# TM 11-6625-335-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

## FIELD DEPOT MAINTENANCE MANUAL

# INDICATOR, STANDING WAVE RATIO AN/UPM-108

*HEADQUARTERS, DEPARTMENT OF THE ARMY*
*21 SEPTEMBER 1960*

## WARNING

DANGEROUS VOLTAGES EXIST
IN THIS EQUIPMENT

Be careful not to contact high-voltage connections or 115-volt input connections when testing or servicing the standing wave indicator.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11-6625-335-35

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *21 September 1960*

# INDICATOR, STANDING WAVE RATIO AN/UPM-108


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# CHAPTER 1

# THEORY

## Section I. GENERAL

### 1. Scope

*a.* This manual covers field and depot maintenance for Indicator, Standing Wave Ratio AN/UPM–108. It includes instructions appropriate to third, fourth, and fifth echelons for troubleshooting, testing, and replacing maintenance parts. It also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed circuit operation is described in the theory section.

*b.* The complete technical manual for this equipment includes three other publications.

TM 11–6625–335–12, Operator's and Organizational Maintenance Manual, Indicator, Standing Wave Ratio AN/UPM–108.

TM 11–6625–335–20P, Organizational Maintenance Repair Parts and Special Tools List for Indicator, Standing Wave Ratio AN/UPM–108.

TM 11–6625–335–35P, Field and Depot Maintenance Repair Parts and Special Tools List for Indicator, Standing Wave Ratio AN/UPM–108.

*c.* Forward comments concerning this manual to the Commanding Officer, U.S. Army Signal Materiel Support Agency, ATTN: SIGMS–PA2d, Fort Monmouth, N. J.

*Note.* For applicable forms and records, see paragraph 2, TM 11–6625–335–12.

### 2. General Application

*Note.* The IM–157/U is the main component of the AN/UPM–108.

*a.* Indicator, Standing Wave Ratio IM-157/U is a 1,000-cycle per second (cps) tuned voltmeter used in conjunction with a slotted line and detector (crystal or barretter) for measuring standing wave ratio (swr) in radiofrequency (rf) transmission line. In operation, an rf signal generator is connected to an rf transmission line through a matching slotted line. The other end of the slotted line is connected to the load normally used with the rf transmission line.

*b.* The signal generator is tuned to the frequency specified for the rf transmission line measurement. The rf signal from the signal generator is modulated with a 1,000-cps square wave (square wave is preferred over sine wave). A detector probe (located on the slotted line) penetrates the slotted line and detects the 1,000-cps modulation. The voltage level of the detected 1,000-cps modulation is directly proportional to the rf power level in the slotted line at the point of probe penetration. The standing wave indicator indicates the relative levels of the rf power as the probe is moved along the slotted line. The ratio between a minimum and a maximum voltage point is determined by arbitrarily setting a standing wave peak to obtain a reading of 1.0 on the meter, and then moving the probe to a dip and reading the swr directly on the meter.

## Section II. UNIT THEORY

### 3. Block Diagram (fig 1)

The standing wave indicator consists of a six-stage resistance-capacitance (rc) coupled amplifier, an indicating meter, and a regulated power supply. The rc coupled amplifier is divided into a three-stage input amplifier, a single-stage 1,000-cycle amplifier, and a two-

stage meter amplifier. The stages of the standing wave indicator are described in *a* through *e* below.

*a.* The input selector switching circuit couples the input signal from a detector (located on the slotted line) to the input amplifier. Direct-current (dc) bias from the bolometer bias current switching circuit for use with barretter detectors can also be applied through the J2 MONITOR jack to the INPUT connector.

*b.* The three-stage input amplifier provides a gain of approximately 12,000. The input level to each of the three stages is controlled by a section of the RANGE selector switch. The input signal level to the third stage is also controlled by the METER SCALE switch which can reduce the meter reading by —5 db. The output signal from the input amplifier is coupled to the input of 1,000-cycle amplifier V2B.

*c.* The 1,000-cycle ampliler, V2B, consists of a single triode tube with a fixed-tuned, 1,000-cps filter in its plate circuit. The input signal level coupled to the 1,000-cycle amplifier is continuously adjustable by the front-panel VERNIER GAIN controls. The output signal from the selective amplifier is coupled to the input of meter amplifier V3A.

*d.* The two-stage meter amplifier, V3A and V3B, provides the output to the indicating meter. Degenerative feedback to both stages provides the linear response required for accurate scale readings. The meter amplifier drives a rectifier which supplies current to the meter. The feedback voltage is obtained through the rectifier circuit to improve the linearity of the crystal rectifiers. The front-panel METER SCALE switch adjusts meter circuit voltages to provide EXPAND scale readings. The meter circuits also contain a closed-circuit jack which provides an output connection to operate an external recorder if desired.

*e.* The power supply consists of power transformer T1, vacuum tube rectifier V4, and a voltage regulator circuit which supplies all power to operate the electron tubes. The output voltage is regulated both with regard to changes in line voltage and changes in load current; regulated dc power stabilizes tube operation and gives steady meter indications. The voltage regulator output is adjustable over a small range to obtain exactly 245 volts dc.

### 4. Input Selector Switching Circuit (fig. 2)

*a.* The input selector switching circuit permits the standing wave indicator to be used with either crystal or barretter detectors. When INPUT SELECTOR switch S3 is in the BOLO-200Ω or XTAL-200Ω position, the input signal is fed to the primary of input transformer T2. These two positions of the switch are for use with crystal detectors. In the XTAL-200KΩ position, the input signal is fed through capacitor C1 to the grid of V1A, through switch S5C. The XTAL-200KΩ position is used with detectors which have a self-contained video load resistor (about 10K), to obtain the best square-law rectifications characteristic over the widest possible range of rf power level.

*b.* When S3 is in the BOLO-200Ω position, the primary of T2 is connected to the bolometer bias current switching circuit instead of to ground. This permits bolo bias current to be used with an external barretter (bolometer). The transformer primary presents a 200-ohm load to the input signal source and provides a voltage gain of 28.5. Capacitor C2 provides an alternating-current (ac) ground to the primary winding of T2 and the power supply. The signal from T2 secondary is fed to the grid of V1A through switch S5C (fig. 16).

### 5. Input Amplifier Circuit (fig. 3)

*a.* The input amplifier consists of three stages, V1A, V1B, and V2A. The first stage, V1A, is a conventional rc coupled audio amplifier circuit using one-half of a 12AX7 voltage amplifier tube to provide a voltage gain of 12.5. Cathode bias resistor R10 is not bypassed to help stabilize gain. Resistor R9 is the plate load; resistors R4 through R8 form a grid return resistor network and voltage divider for the first stage. The RANGE switch provides a 10 to 1 decrease (or increase) in the signal voltage level applied to the grid of V1A. Capacitor C4 couples the

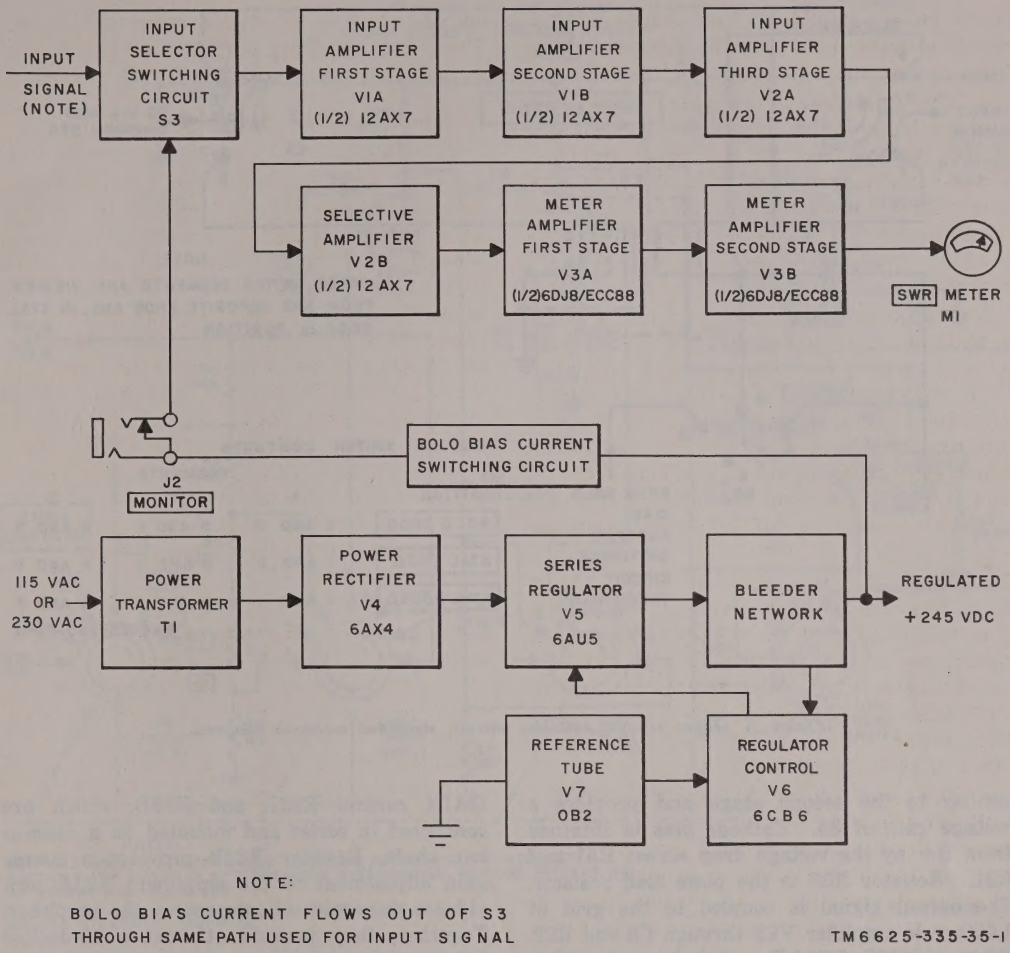

INPUT SIGNAL (NOTE)
INPUT SELECTOR SWITCHING CIRCUIT S3
INPUT AMPLIFIER FIRST STAGE V1A (1/2) 12AX7
INPUT AMPLIFIER SECOND STAGE V1B (1/2) 12AX7
INPUT AMPLIFIER THIRD STAGE V2A (1/2) 12AX7
SELECTIVE AMPLIFIER V2B (1/2) 12AX7
METER AMPLIFIER FIRST STAGE V3A (1/2)6DJ8/ECC88
METER AMPLIFIER SECOND STAGE V3B (1/2)6DJ8/ECC88
SWR METER M1
J2
MONITOR
BOLO BIAS CURRENT SWITCHING CIRCUIT
115 VAC OR 230 VAC
POWER TRANSFORMER T1
POWER RECTIFIER V4 6AX4
SERIES REGULATOR V5 6AU5
BLEEDER NETWORK
REGULATED +245 VDC
REFERENCE TUBE V7 OB2
REGULATOR CONTROL V6 6CB6
NOTE:
BOLO BIAS CURRENT FLOWS OUT OF S3 THROUGH SAME PATH USED FOR INPUT SIGNAL
TM6625-335-35-1

*Figure 1. Indicator Standing Wave Ratio IM–157/U, block diagram.*

output signal from V1A to V1B through S5B front.

*b.* The input amplifier second stage, V1B, differs from the first in that its cathode voltage is increased by drawing a constant current from +245 volts dc (regulated power supply) through R52 and cathode bias resistor R14. This provides linear operation of V1B without increasing the cathode resistance or decreasing the gain. Capacitor C3C bypasses R14 and reduces degeneration. Resistors R11 and R12 provide attenuation of the signal level to V1B when the RANGE switch is set to 40DB or less. When switch S5B (front) is in either the 50DB or 60DB position, the grid of V1B is connected directly to C4, and R11 and R12 are placed in series to ground as the grid return resistors. Resistor R13 is the plate load resistor and C5 couples the output signal from V1B to the grid of V2A through the rear of S5A.

*c.* The input amplifier third stage, V2A, is

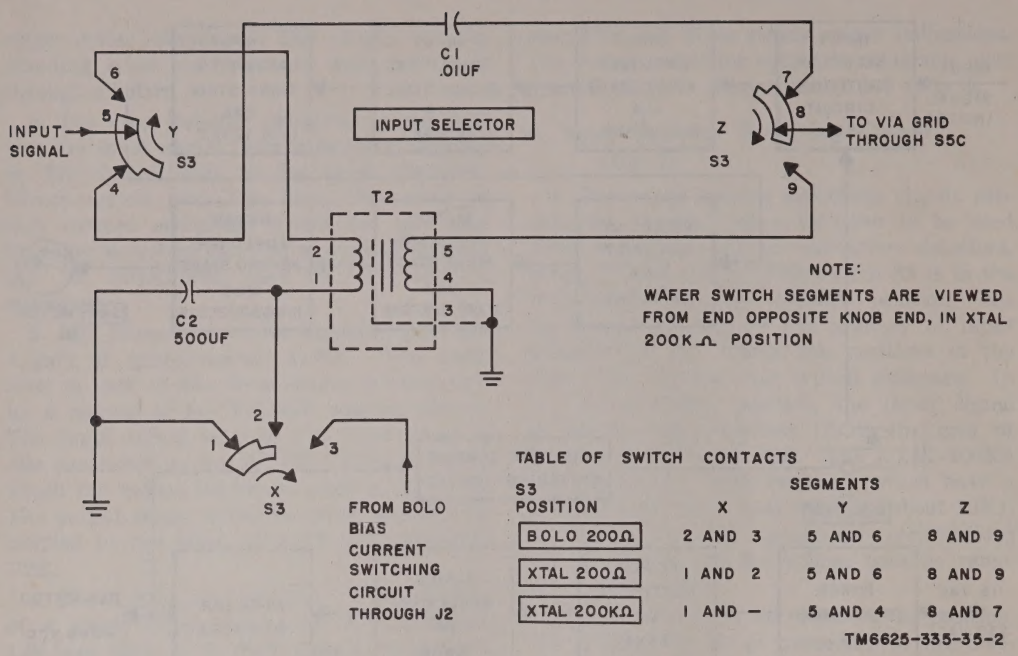


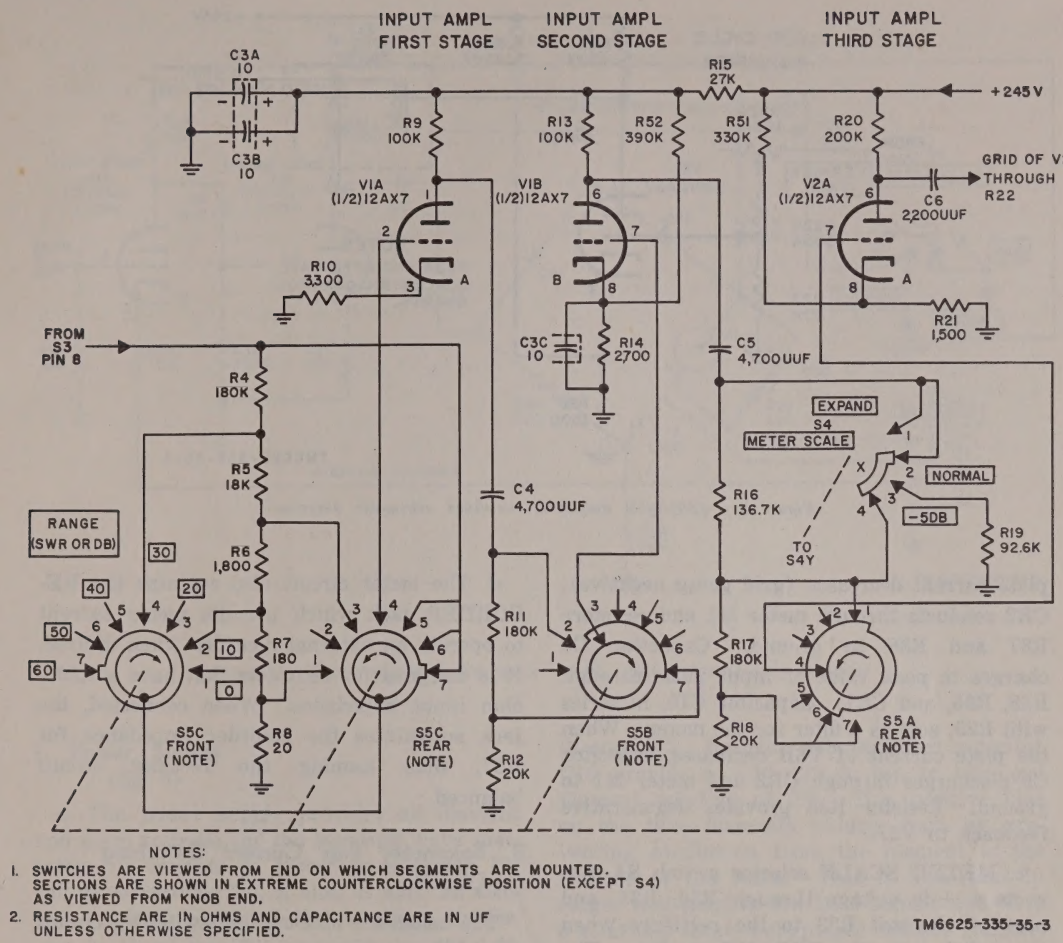

*Figure 2. Input selector switching circuit, simplified schematic diagram.*

similar to the second stage and provides a voltage gain of 35. Cathode bias is obtained from B+ by the voltage drop across R51 and R21. Resistor R20 is the plate load resistor. The output signal is coupled to the grid of 1,000-cycle amplifier V2B through C6 and R22. When METER SCALE switch S4 is in either the NORMAL or the EXPAND position, the signal from C5 is coupled directly to the grid of V2A through S4 and S5A rear. When switch S4 is in the −5DB position, voltage divider R16 and R19 is placed in the signal path, and the sensitivity of the amplifier is decreased. The rear section of RANGE switch S5A and R17 and R18 form a voltage divider network to control the amplitude of the input signal applied to the grid of V2A.

## 6. Amplifier, 1,000-Cycle (fig. 4)

*a.* The 1,000-cycle amplifier, V2B, receives the input signal from C6 through VERNIER GAIN control R22A and R22B, which are connected in series and mounted on a concentric shaft. Resistor R22B provides a coarse gain adjustment of the amplifier; R22A provides a fine gain adjustment of the amplifier. Together, they provide at least a 10-decibel (db) continuous adjustment of the input signal applied to V2B. Resistor R23 limits the maximum range of adjustment to 13 db and provides a protective minimum grid-to-ground resistance. Cathode bias for the stage is obtained from the +245 volts by the voltage drop across R50 and R25. Resistor R24 is the plate load for the tube, and C7 couples the signal from the plate of V2B to filter Z1.

*b.* The plate circuit is loaded with the 1,000-cps parallel resonant filter Z1, which has a Q between 20 and 30. Filter Z1 allows a 1,000-cps signal to pass without being attenuated. The decreased impedence of filter Z1 at frequencies other than 1,000 cps bypasses these frequencies to ground. The effective




NOTES:

1. SWITCHES ARE VIEWED FROM END ON WHICH SEGMENTS ARE MOUNTED. SECTIONS ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION (EXCEPT S4) AS VIEWED FROM KNOB END.
2. RESISTANCE ARE IN OHMS AND CAPACITANCE ARE IN UF UNLESS OTHERWISE SPECIFIED.

TM6625-335-35-3

*Figure 3. Input amplifier, simplified schematic diagram.*

bandwidth of the filter is approximately 40 cps at the halfpower points. The stage has a gain of only three due to the low impedence that results from tapping into the inductor. The output signal is coupled from Z1 directly to the grid of meter amplifier V3A.

## 7. Meter Amplifiers (fig. 5)

*a.* The output signal from the 1,000-cycle amplifier is applied to the grid of V3A, the first stage of the meter amplifier. Resistor R26 maintains the grid operating point if filter Z1 opens or is removed. Resistor R28 is the cathode bias resistor and R27 is the plate load resistor. The output signal is coupled to the grid of V3B, the second stage of the meter amplifier, through capacitor C8. Resistor R30 is the grid resistor for V3B, R31 is the plate load resistor, and R32 provides cathode bias.

*b.* The output from V3B is coupled to crystal rectifiers CR1 and CR2 through coupling capacitor C9. When the plate current of V3B increases (grid going positive), CR2 conducts through meter M1, RECORDER jack J3 and resistors R37 and R38 to ground. When the

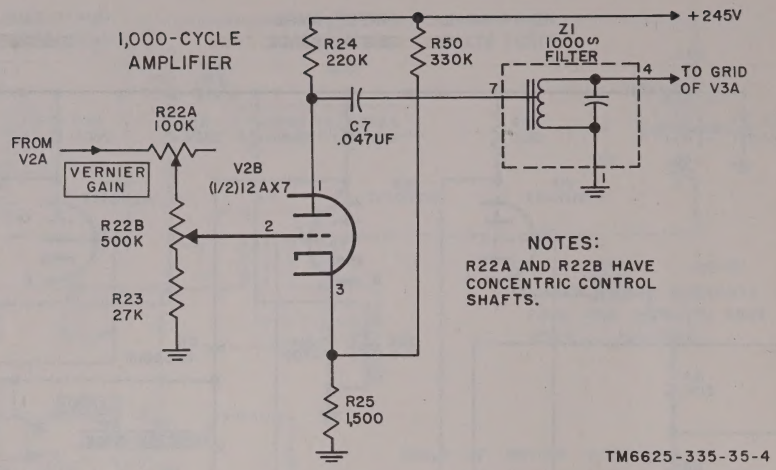



*Figure 4. 1,000-cycle amplifier, simplified schematic diagram.*

plate current decreases (grid going negative), CR2 conducts through meter M1 and resistors R37 and R38 to ground. Capacitor C9 charges to peak value of input pulse through R38, R36, and CR1. Capacitor C10, in series with R29, acts as a filter for the meter. When the plate current of V3B decreases, capacitor C9 discharges through CR2 and meter M1 to ground. Resistor R38 provides degenerative feedback to V3A.

*c.* METER SCALE selector switch S4 connects a +dc voltage through R34, R35, and part of rheostat R33 to the rectifiers when the switch is in the EXPAND position. The resultant reverse current through the meter causes it to indicate off-scale (downward on the EXPANDED SWR scale) by about 8 db. The meter is brought back to a full-scale reading by increasing the sensitivity of the input amblifier, using RANGE switch S5 and/or the GAIN control. The expand voltage is applied equally to both legs of the rectifiers to prevent clamping the plate voltage swing of V3. This maintains equal rectification characteristics on the negative and positive halves of the plate voltage cycle. Resistor R33 permits the expand voltage to be adjusted to obtain an exact degree of scale expansion.

*d.* The meter circuit also contains the RECORDER jack which permits meter current to operate an external recorder when desired. It is designed for recorders that have a 1,500-ohm input impedance. When connected, the jack substitutes the recorder impedance for R37, thus keeping the rectifier circuit balanced.

## 8. Bolometer Bias Current Switching Circuit

The bolometer bias current switching circuit (fig. 16) provides two different levels of current for the operation of two different types of barretter detectors, a high-current detector or a low-current detector. BOLO BIAS CURRENT switch S2 determines the current level by shunting one of the resistors in voltage divider R1, R2 and R3 connected between +245 volts dc and ground. Resistors R2 and R3 are in series and R1 is parallel with R2. With S2 in the HIGH position, R1 is open and the junction of R2 and R3 provides a current of 8.4 milliamperes to a barretter detector; with S2 in the LOW position, R2 is shunted by R1 so that the junction provides a current of only 4.3 milliamperes.

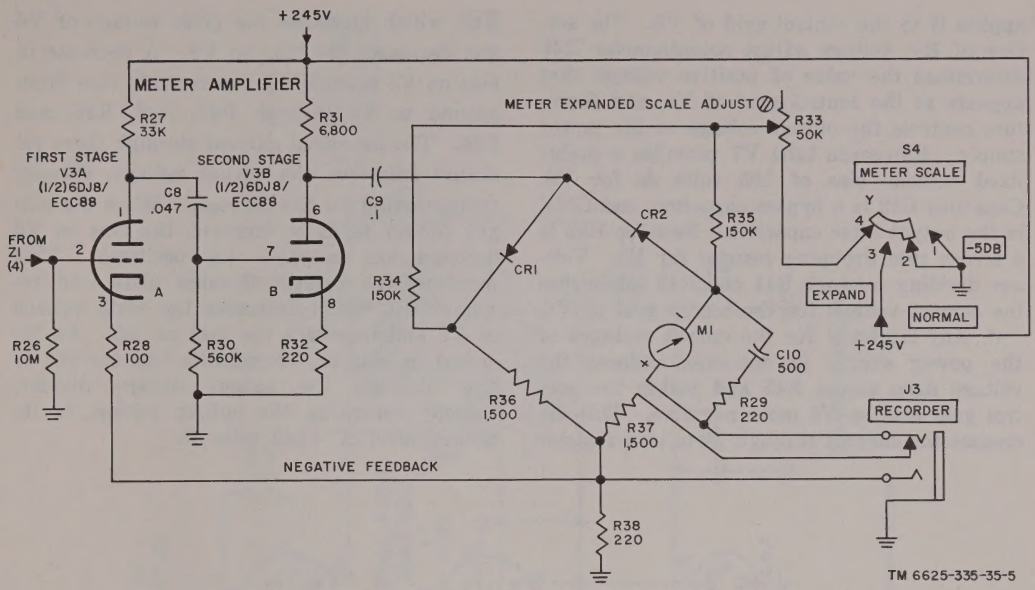



*Figure 5. Meter amplifier and meter circuit, simplified schematic diagram.*

## 9. Power Supply (fig. 6)

*a.* The power supply provides all filament and plate voltages for the standing wave indicator. It consists of power transformer T1, full-wave rectifier V4, a filter circuit, an electronic voltage regulator, and a voltage divider.

*b.* Power switch S1 and fuse F1 are in series with the primary windings of power transformer T1. The power transformer has two primary windings. When the test set is operated from a 115-volt ac power source, the two primary windings are connected in parallel; when the test set is operated from a 230-volt ac power source, the two primary windings are connected in series. Two of the secondary windings supply filament voltage to the tubes and the LINE POWER indicator lamp. The center-tapped high-voltage (hv) secondary winding supplies 350 volts ac to the plates of full-wave rectifier tube V4. The dc output voltage of V4 is filtered by C11A and C11B. Resistor R49 acts as a surge limiting resistor in the filament circuits of tubes V1 through V3. Resistor R48 and filter capacitor C13 provide a +10-volt dc tap to bias one filament winding of T1. This positive bias on the tube filaments reduces hum by preventing conduction from the filament to the cathode of the tubes. This is important in stages that amplify low-level signals and have a relatively large, unbypassed cathode resistor, such as V1 through V3.

*c.* The electronic voltage regulator consists of series regulator tube V5, regulator control tube V6, and reference tube V7. The cathode voltage of V5 (+245 volts) is held constant by holding the control grid voltage constant with regulator control V6 and reference tube V7. A change in output voltage due to a change either in input (line) voltage or in the load current is corrected by automatic adjustment of the series regulator grid bias. A sample of the output voltage is obtained from R45 located in voltage divider network R44, R45, R46, and R48, and is coupled to the control grid of V6 through current limiting resistor R43. Regulator control V6 amplifies any variation of the output voltage and

applies it to the control grid of V5. The setting of B+ voltage adjust potentiometer R45 determines the value of positive voltage that appears at the control grid of V6, and therefore controls the output voltage of the power supply. Reference tube V7 provides a stable fixed cathode bias of 105 volts dc for V6. Capacitor C12 is a bypass capacitor, and C11C is the output filter capacitor. Resistor R39 is a screen grid dropping resistor for V5. Voltage dividing network R41 and R42 establishes the correct voltage for the screen grid of V6.

*d.* Any tendency for the output voltages of the power supply to decrease, reduces the voltage drop across R45 and makes the control grid bias on V6 more negative. This decreases the current through plate load resistor R40, which increases the plate voltage of V6 and decreases the bias on V5. A decrease in bias on V5 permits more current to flow from ground to V5 through R48, R46, R45, and R44. The increased current through these resistors increases the output voltage, thereby compensating for the decrease. When the output voltage tends to increase, the bias on V6 becomes less negative (or positive). This increases the current through plate load resistor R40, which decreases the plate voltage of V6 and increases the bias on V5. An increase in bias on V5 permits less current to flow through the output voltage divider, thereby returning the output voltage to its normal level of +245 volts dc.

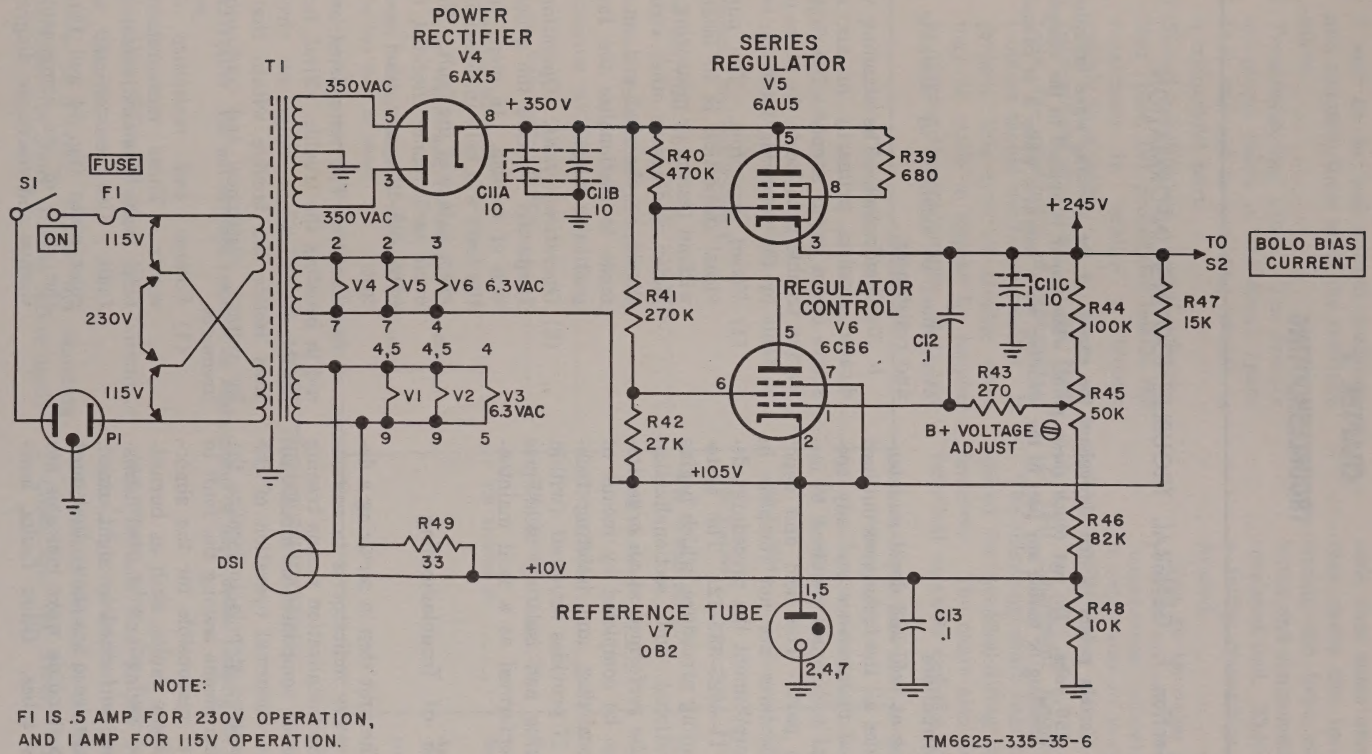



*Figure 6. Power supply, simplified schematic diagram.*

# CHAPTER 2

# TROUBLESHOOTING

## Section I. GENERAL TROUBLESHOOTING INFORMATION

**WARNING: Certain points located throughout the chassis of the standing wave indicator operate at voltages above 250 volts. Do not touch these points while power is applied to the equipment. Be very careful when handling or testing any part of the standing wave indicator while it is connected to a power source.**

### 10. General Instructions

Troubleshooting at field and depot maintenance levels includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedures described in TM 11–6625–335–12. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at an organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques. Section II provides *intraunit* (within the unit) localizing and isolating techniques that must be performed at a field maintenance level.

### 11. Organization of Troubleshooting Procedures

*a. General.* The first step in servicing a defective standing wave indicator is to sectionalize the fault. Sectionalization means tracing the fault to a major component or circuit responsible for the abnormal operation of the indicator. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults, such as burned-out resistors and arcing and shorted transformers, often can be located by sight, smell, and hearing. Experience has shown that most troubles with the standing wave indicator are caused by faulty tubes. Other faults, however, must be localized by checking voltages and resistances.

*b. Sectionalization.* The standing wave indicator consists primarily of six amplifier stages and a power supply. The first step in tracing trouble is to locate the stage or stages at fault by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. Meter readings or other visual signs should be observed and an attempt made to sectionalize the fault to a particular stage.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. The equipment performance checklist (TM 11–6625–335–12) is a good operational test.

*c. Localization.* The tests listed below will aid in isolating the trouble. First, isolate the trouble to a single stage or circuit and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements.

(1) *Voltage and resistance measurements.* These measurements will help locate the individual part at fault. Use resistor and capacitor color codes (fig. 14 and 15) to find the value of the components. Use voltage and resistance diagrams (fig.

7 and 8) to find normal readings, and compare them with the readings taken.

(2) *Troubleshooting chart.* The trouble symptoms listed in the chart (para 15*d*) will aid in localizing trouble to a component part.

(3) *Signal substitution.* Signal substitution (para 16) procedures enable the repairman to localize a trouble quickly to a stage.

(4) *Intermittent troubles.* In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. It is possible that some external connections may cause the trouble. Check the wiring for loose connections; move wires and components gently with an insulated tool. This may show where a faulty connection or component is located.

*Note.* Do not change positions of wires or parts in the area of the RANGE switch. Range-to-range calibration errors will occur if certain wires are moved from their original positions.

## 12. Test Equipment Required

The following chart lists test equipment required for troubleshooting the standing wave indicator. The chart also lists the associated technical manuals and the common names.

| Test equipment | Technical manual | Common name |
|---|---|---|
| Voltmeter, Meter ME–30A/U | TM 11–6625–320–12. | Ac vtvm |
| Attenuator TS–402A/U (2 required) | TM 11–2044 | Attenuator set |
| Crystal Rectifier Test Set TS–268/U. | TM 11–1242 | Crystal tester |
| Multimeter AN/URM–105 | TM 11–6625–203–12. | Vtvm |
| Audio Oscillator TS–382D/U (or equivalent). | TM 11–2684A | Audio oscillator |
| Signal Generator AN/URM–61 | TM 11–5091 | Rf Signal generator |
| Slotted Line, Wave guide IM–92/U | TM 11–5109 | Slotted line |
| Signal Generator SG–299/U | TM 11–5134–15 | Square wave generator |
| Variable power transformer, 115-230-volt, with meter. | | Autotransformer |
| Dc ammeter, 0–10 milliamperes (internal resistance must be less than 20 ohms). | | Milliammeter |

## Section II. UNIT TROUBLESHOOTING

**CAUTION: Do not attempt removal or replacement of parts before reading the instructions in paragraph 19.**

## 13. Checking Filament and B+ Circuits For Shorts

*a. When to Check.* Check the standing wave indicator for short circuits before applying power when the fuse is blown, there are signs of components overheating, or a defective part is located in the power supply.

*b. Conditions for Tests.* Prepare for the

short-circuit tests as follows:

(1) Remove the standing wave indicator from its case (TM 11–6625–335–12).

(2) Remove all tubes and the LINE POWER indicator lamp (TM 11–6625–335–12). Mark V1 and V2 so that they can be returned to their original tube sockets.

*c. Measurements.* Make the resistance measurements indicated in the following chart. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

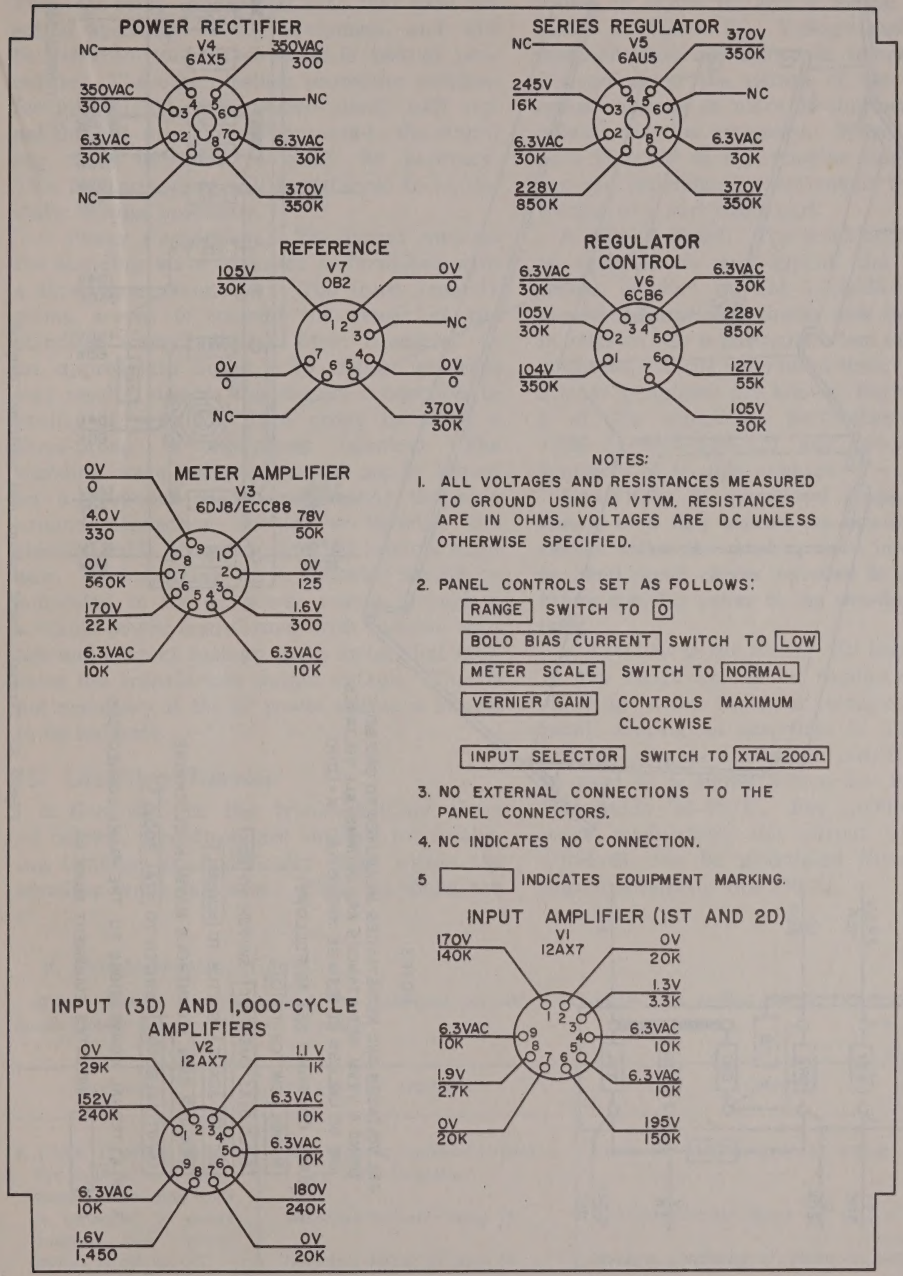
Short-Circuit Tests

| Point of measurement | Normal indication | Isolating procedure |
|---|---|---|
| Between pins 4 and 5 of tube socket XV3 and 2 and 7 of tube socket XV4. | 0.5 ohm | Zero resistance indicates a short circuit in filament winding. Check continuity of T1 filament windings (para 17). Infinite resistance indicates an open filament winding. |
| Across ac plug P1 terminals with switch S1 in ON position. | 9.0 ohms | Zero resistance indicates a short in the primary winding of transformer T1 or in the wiring of the LINE POWER switch. Infinite resistance indicates an open fuse, open transformer winding, defective switch S1, or incorrect or incomplete connections of jumper wires on T1 primary. |
| From pin 5 to pin 3 of tube socket XV4. | 61 ohms | If resistance is low, check for a short between each red lead of T1 and ground. If resistance is infinite, check for an open in the high-voltage secondary of T1. |
| From pin 3 of socket XV5 to ground. | Approximately 16,000 ohms. | If resistance is low, check for shorted capacitor C3A, C3B, C11A, or C11B, or for a short circuit in the high-voltage wiring. Be sure the negative lead for the ohmmeter is connected to the chassis, or a false low reading may be obtained. If the resistance is higher than normal, check for an open resistor in the power supply and B+ circuits. If the resistance is zero, C11C is shorted. |

## 14. Preliminary Testing Information

*a. General.* The standing wave indicator can be operated from a 115- or 230-volt ac source depending on the primary winding corrections of power transformer T1. Before plugging into an ac power source, see that the transformer is connected properly for the ac power available (TM 11–6625–335–12).

*b. Dynamic and Static Testing.* Two testing procedures can be used to test the standing wave indicator. One test involves connecting the standing wave indicator to Slotted




NOTES:

1. ALL VOLTAGES AND RESISTANCES MEASURED TO GROUND USING A VTVM. RESISTANCES ARE IN OHMS. VOLTAGES ARE DC UNLESS OTHERWISE SPECIFIED.

2. PANEL CONTROLS SET AS FOLLOWS:

   | | |
   |---|---|
   | RANGE | SWITCH TO 0 |
   | BOLO BIAS CURRENT | SWITCH TO LOW |
   | METER SCALE | SWITCH TO NORMAL |
   | VERNIER GAIN | CONTROLS MAXIMUM CLOCKWISE |
   | INPUT SELECTOR | SWITCH TO XTAL 200Ω |

3. NO EXTERNAL CONNECTIONS TO THE PANEL CONNECTORS.

4. NC INDICATES NO CONNECTION.

5 [ ] INDICATES EQUIPMENT MARKING.

TM6625-335-35-12

*Figure 7. Tube-socket voltage and resistance diagram.*

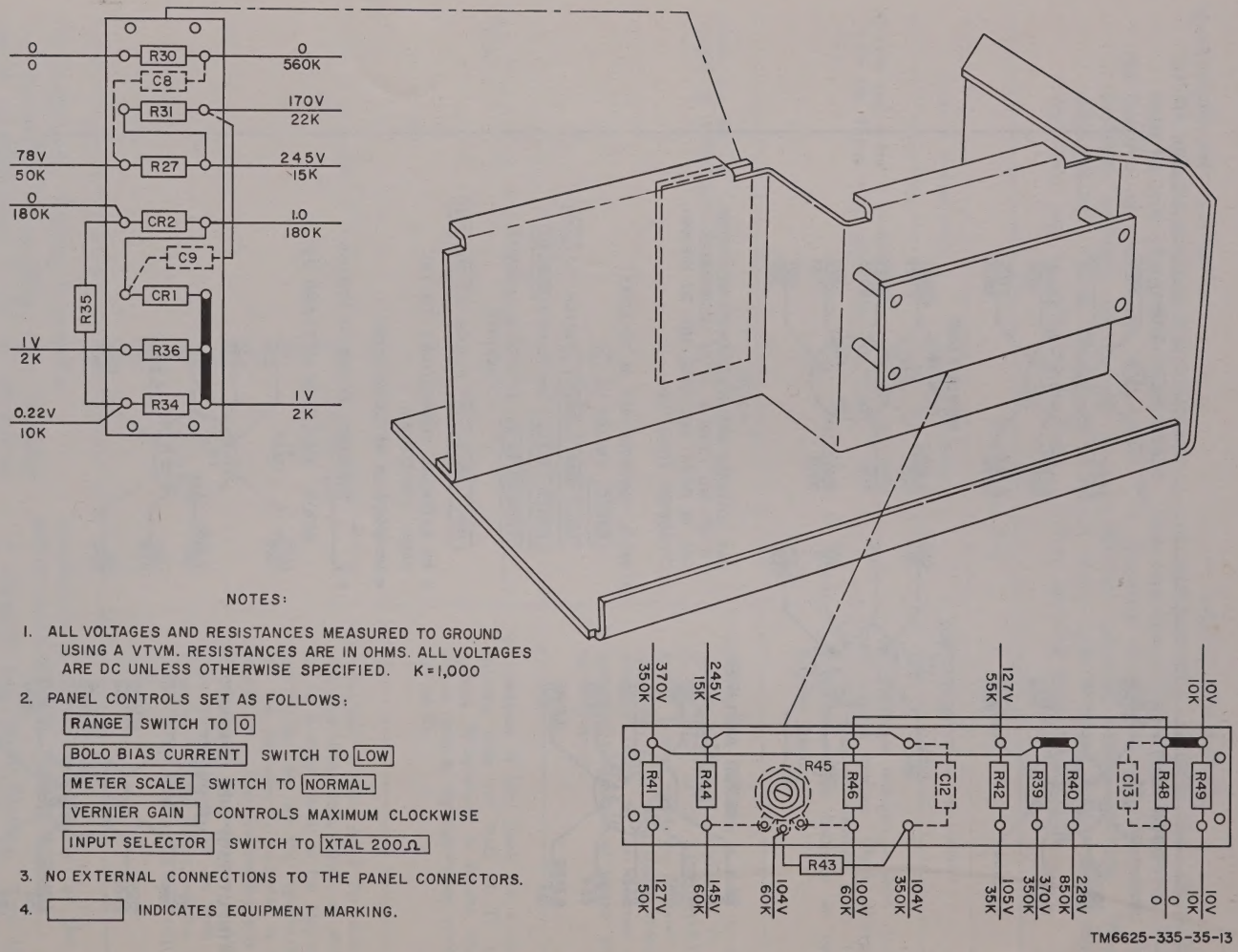



*Figure 8. Terminal board voltage and resistance diagram.*

Line, Waveguide IM–92/U and using Signal Generator AN/URM–61 as a signal source. This test setup is identical with that used for actual operation of the equipment, and will be referred to as the dynamic testing procedure. The other testing procedure involves feeding a 1,000-cycle audiofrequency (af) signal through precision attenuators to the standing wave indicator to check its accuracy. This test procedure will be referred to as the static testing procedure.

*c. Power Connections.* The power cord on the standing wave indicator is furnished with a three-prong connector. The third (round) prong serves to ground the chasis of the standing wave indicator when connected to an appropriate outlet. To obtain accurate test results, disable the chassis connection to ground through the third prong by using a three-prong to two-prong adapter. The standing wave indicator should not be placed on a grounded metal workbench; the only ground connection should be through the shielded cable from the external input attenuator. The standing wave indicator should be connected to the ac power source through a variable power transformer with suitable voltage and current ratings and a meter that indicates the transformer output votage. This is not necessary if the ac power source is known to be accurate.

## 15. Localizing Troubles

*a. General.* In the troubleshooting chart (*d* below), procedures are outlined for localizing troubles to a particular stage within the standing wave indicator. Parts locations are shown in figures 9 through 12. A schematic diagram of the standing wave indicator is shown in figure 16, and a wiring diagram is shown in figure 17. Voltage and resistance measurements are shown in figures 7 and 8. Depending on the nature of the operational symptoms, one or more of the localizing procedures may be necessary. When trouble has been localized to a particular stage, use voltage and resistance measurements to isolate the trouble to a particular part.

*b. Use of Chart.* The troubleshooting chart is designed to supplement the operational checks detailed in TM 11–6625–335–12. If previous operational checks now have resulted in reference to a particular item of this chart, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist (TM 11–6625–335–12) and proceed until a symptom of trouble appears.

**CAUTION: If operational symptoms are not known, or if they indicate the possibility of short circuits within the standing wave indicator, make the short-circuit checks described in paragraph 13 before applying power to the standing wave indicator.**

*c. Conditions for Tests.* All checks outlined in the chart are to be conducted with the standing wave indicator connected for dynamic testing as described in TM 11–6625–335–12. Signal Generator AN/URM–61 will be used as a signal source for Slotted Line, Waveguide IM–92/U. For 1,000-cycle square wave modulation, the output of the AN/URM–61 can be modulated through use of Signal Generator SG–299/U.

*d. Troubleshooting Chart.*

*Note.* Perform the operations in the equipment performance checklist (TM 11–6625–335–12) before using this chart, unless trouble has already been localized.

| Symptom | Probable trouble | Correction |
|---|---|---|
| 1. LINE POWER indicator light is not illuminated when line cord is connected to power source and power switch is set to ON. | No ac power applied to standing wave indicator. | Check for proper input line voltage. |
| | Defective indicator lamp I1 __ | Replace indicator lamp. |
| | Defective wiring to lamp I1 __ | Measure continuity of wiring to lamp. |

| Symptom | Probable trouble | Correction |
|---|---|---|
| | R49 open | Check and replace if necessary. |
| | Open fuse F1 | Replace fuse F1. |
| | Transformer T1 not properly strapped. | If fuse blows, check strapping of power transformer T1 (TM 11-6625-335-12). Check for proper fuse value. Fuse F1 should be 1 ampere slow-blow, for 115-volt operation, or 0.5 ampere slow-blow for 230-volt operation. |
| | Defective transformer T1 | Check resistance (para 17) of T1; replace if defective. |
| | Defective switch S1 | Check with ohmmeter for proper operation; replace if defective. |
| 2. Fuse blows when line cord is connected to power source and power switch is set to ON. | Defective rectifier tube V4 | Check tube and replace if defective. |
| | Defective filter capacitor C3 or C11. | Check all three sections of C3 and C11; replace either capacitor if defective. |
| | Transformer T1 defective | Check dc resistance of transformer T1 after removing all tubes from sockets. Replace T1 if defective. |
| 3. No deflection of meter pointer. | Audio oscillator not set to 1,000-cps frequency of filter Z1. | Check setting of audio oscillator. |
| | Defective input amplifier tube V1, V2, or V3. | Check tube V1, V2, or V3. |
| | Defective crystal diode CR1 or CR2. | Check crystal diodes with the crystal tester. |
| 4. Meter peaks at other than 1,000-cps modulation frequency. | 1,000-cycle filter Z1 defective. | Replace filter Z1. |
| 5. External 0–10 ma dc milliammeter reads more than 4.6 ma or less than 4.0 ma when connected to the MONITOR jack, and BOLO BIAS CURRENT switch S2 is set to LOW. | Power supply circuit is not providing accurate +245 volts dc. | If the dc output voltage is too high or too low, adjust B+ voltage adjust resistor R45 as described in paragraph 20. |
| | Defective power transformer T1. | Check the ac voltage from pin 8 of tube V4 to ground and from pin 5 of tube V4 to ground. The voltage of both pins should be 350 volts ac ±10 percent. If the voltage is low, replace transformer T1. |
| Note. This check can only be performed if a 4.3-ma barretter detector is used. | Resistor R1, R2, or R3 defective. | Replace defective resistor. |
| | Input transformer T2 primary is open. | Check the dc resistance between terminals 1 and 2 of transformer T2 (para 17). Replace the transforme. if defective. |
| **CAUTION: Do not set S2 to HIGH when a 4.3-ma barretter detector is being used.** | Capacitor C2 shorted | Replace capacitor C2. |

| Symptom | Probable trouble | Correction |
|---|---|---|
| | MONITOR jack J2 defective _ | Check the contacts and wiring connection to J2. Repair the wiring; clean all contacts. |
| | Defective barretter _____ | Replace barretter. |
| | BOLO BIAS CURRENT switch S2 is defective. | Check for defective wiring connections. Replace switch S2 if necessary. |
| | INPUT SELECTOR switch S3 defective. | Check the switch contacts. Repair defective wiring connections. Replace switch S3 if necessary. |
| | | Check tubes V4, V5, V6, and V7. If a tube is replaced, readjust the output voltage of the power supply (para 20). |
| | | If the power supply output voltage is low, check all sections of capacitors C3 and C11. Replace any defective capacitor. |
| 6. External 0–10 ma dc milliammeter reads more than 8.8 or less than 8.0 when connected to the MONITOR jack and the BOLO BIAS CURRENT switch is set to HIGH.<br><br>Note. This check can only be performed if an 8.4-ma barretter detector is used. | Same as step 5 above except resistor R1 is now out of the circuit. | Same as step 5. |

## 16. Signal Substitution

*a. General.* Signal substitution procedures help to localize troubles to a stage in a defective standing wave indicator. Use the test setup shown in figure 13 except:

(1) Connect the ac vtvm to the output of the attenuator set.

(2) Do not connect the attenuator set output cable to the standing wave indicator INPUT terminal.

*b. Preliminary Adjustments.*

(1) Adjust the attenuator set for the 30-db attenuation.

(2) Adjust the audio oscillator output frequency to 1,000 cps.

(3) Adjust the audio oscillator output for a 0.01-volt root mean square (rms) reading on the ac vacuum tube voltmeter (vtvm).

(4) Set the controls on the standing wave indicator as follows:
Power switch to off position.
RANGE switch to 0.
VERNIER GAIN controls fully clockwise.
INPUT SELECTOR switch to XTAL 200 .
METER SCALE switch to NORMAL.
BOLO BIAS CURRENT switch to LOW.

*c. Stage Tests.* For the following tests, ground the shield of the attenuator set output cable to the standing wave indicator chassis ground. Connect a 0.1-microfarad (uf), 600-

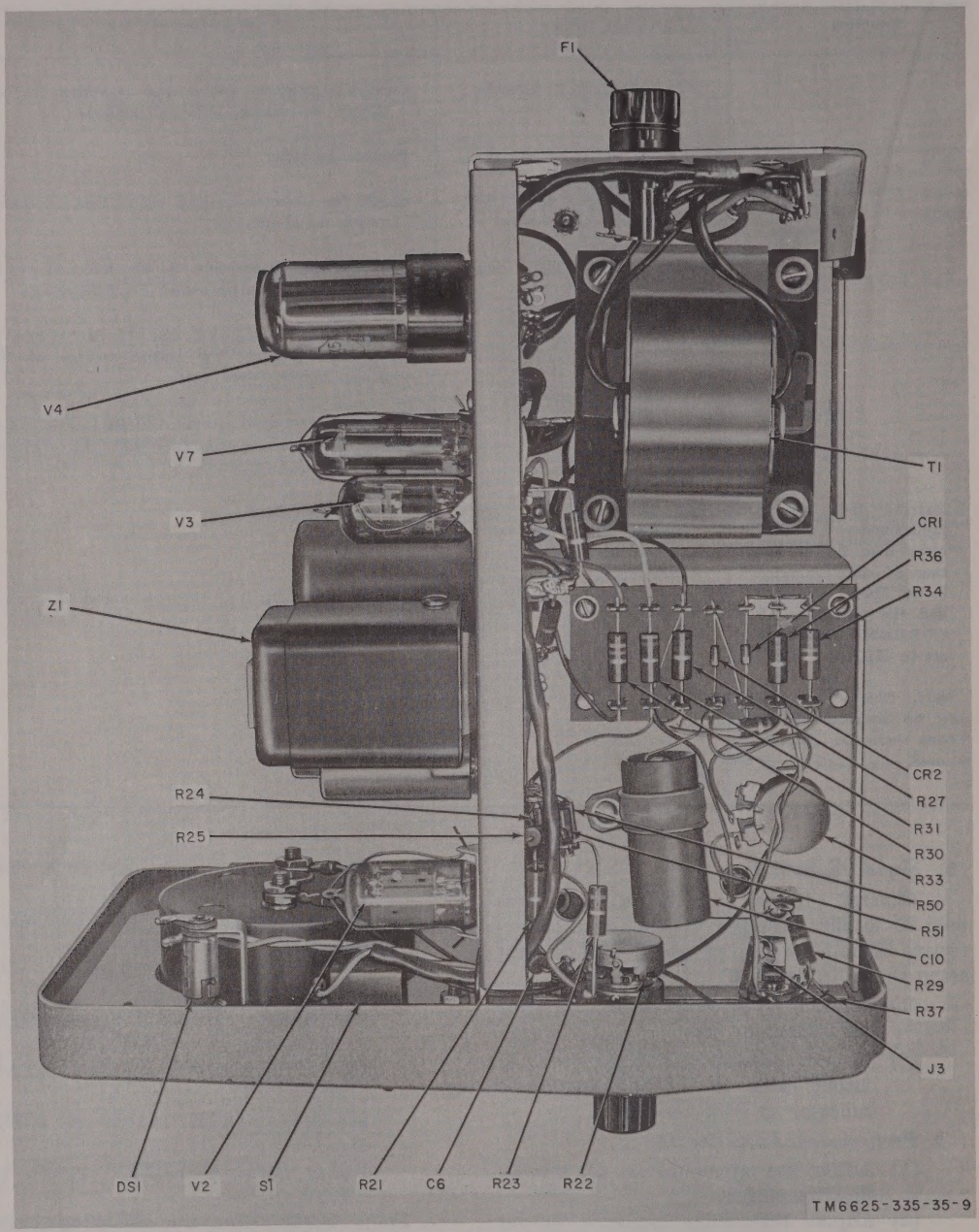



*Figure 9. Panel-chassis assembly, left side view.*

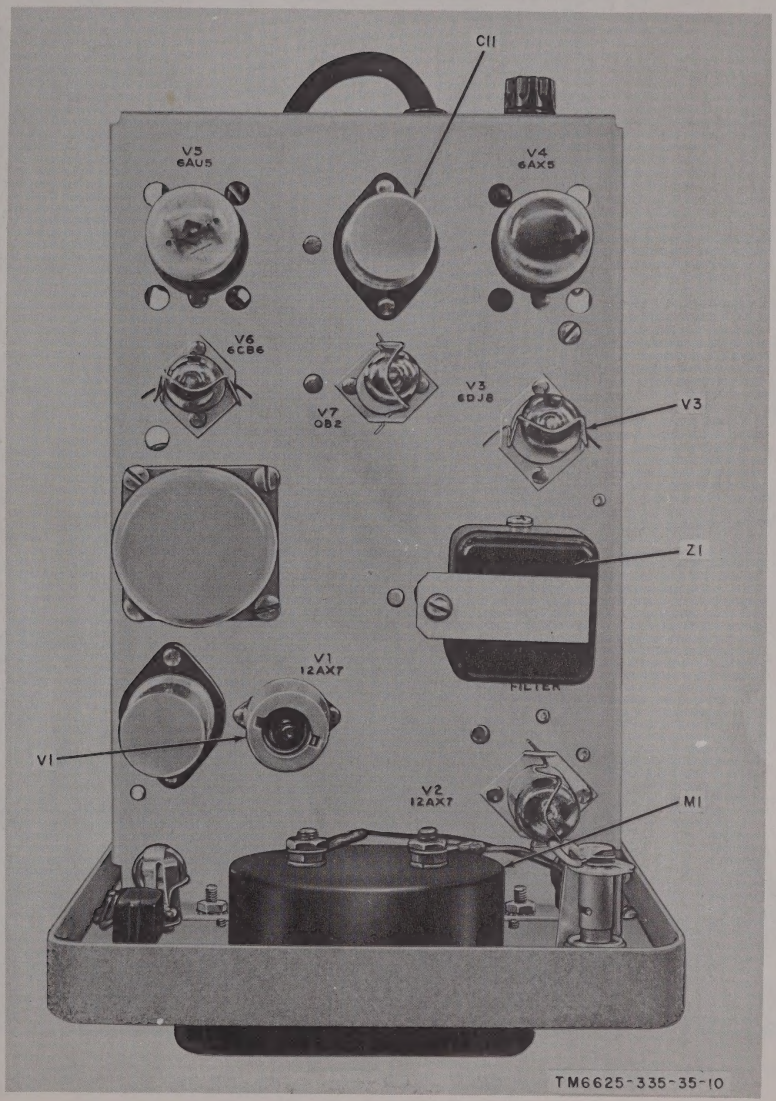



*Figure 10. Panel-chassis assembly, top view.*

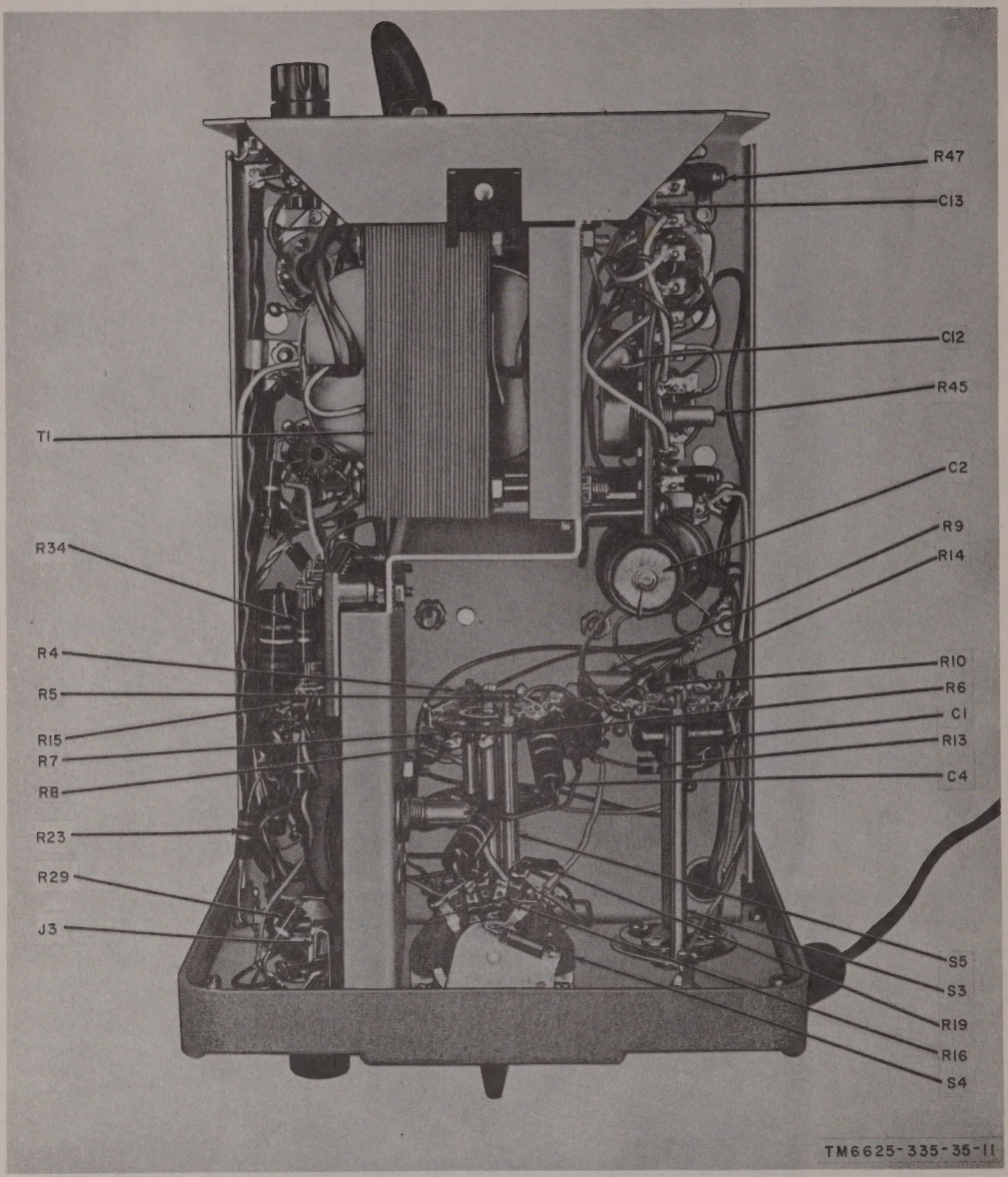



*Figure 11. Panel- chassis assembly, bottom view.*

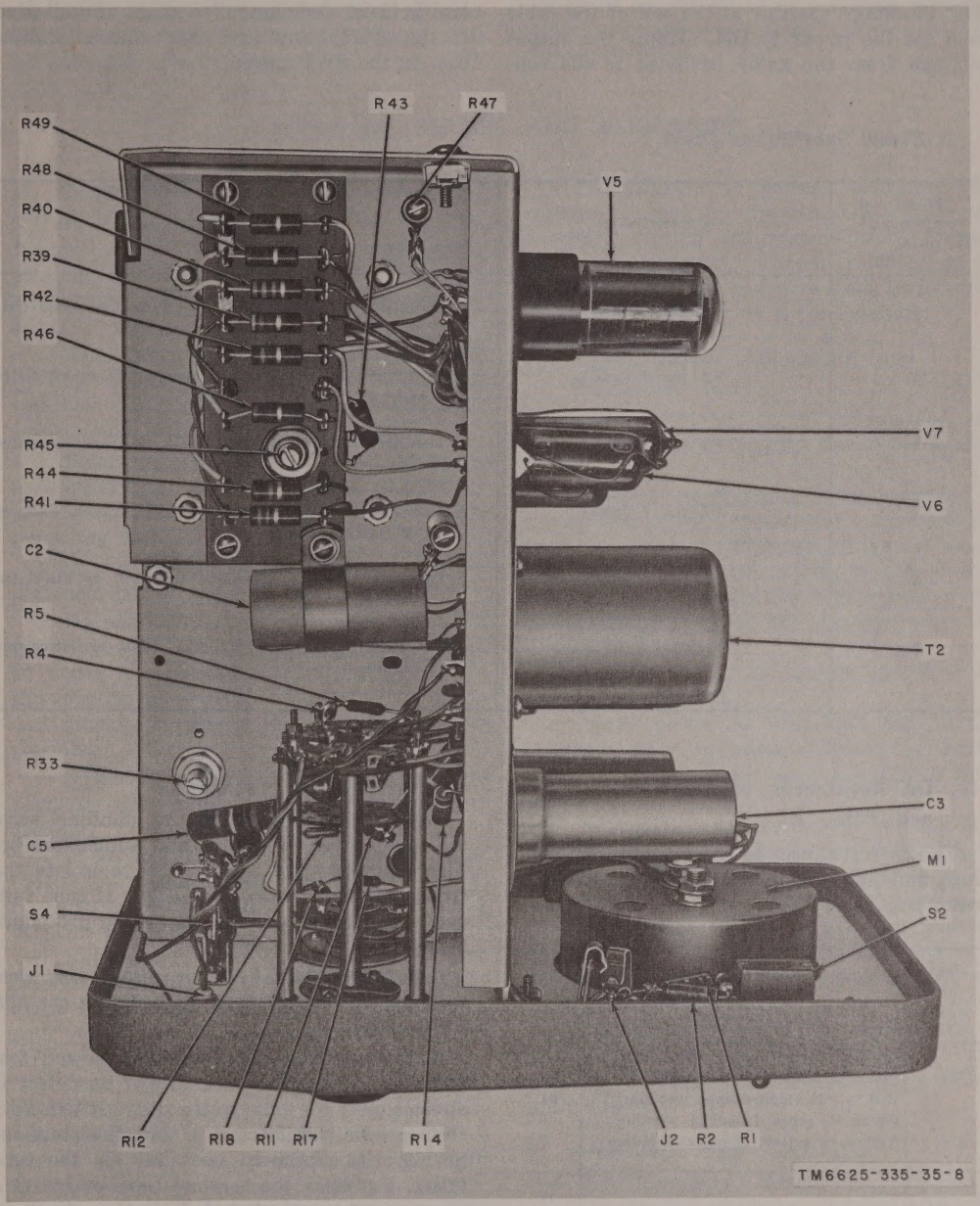



*Figure 12. Panel-chassis assembly, right side view.*

volt blocking capacitor at the end of the cable and set the power to ON. Apply the output voltage from the audio iscillator to the control grid of each amplifier stage as indicated in the chart below and check for an indication on the SWR meter.

*d. Signal Substitution Chart.*

| Signal frequency (kc) | Connection to | Possible trouble |
|---|---|---|
| 1 | V3, pin 2 (grid) | Defective tube V3, capacitor C8 or C9, diode CR1 or CR2, S4Y, or associated resistors. |
| 1 | V2, pin 2 (grid) | Defective tube V2, filter Z1, capacitor C7, or associated resistors. |
| 1 | V2, pin 7 (grid) | Defective tube V2, capacitor C6, S5A, or associated resistors. |
| 1 | V1, pin 7 (grid) | Defective tube V1, capacitor C5, S4X, S5A, S5B, or associated resistors. |
| 1 | V1, pin 2 (grid) | Defective tube V1, capacitor C4, S5B, or associated resistors. |
| 1 | Terminal 2 of transformer T2 | Defective transformer T2, S3, S5C, or associated resistors. |

## 17. Dc Resistances of Transformers and Filter Z1

The dc resistances of the transformer windings and filter Z1 in the standing wave indicator are listed below:

| Transformer or filter | Terminals | Ohms |
|---|---|---|
| T1 | Black to black-red (primary) | 8 |
| | Red to red (high-voltage secondary) | 61 |
| | Green to green (filament winding) | 0.5 |
| | Yellow to yellow (filament winding) | 0.5 |
| T2 | 1–2 | 17 |
| | 4–5 | 75 |
| Z1 | 4–7 | 16 |
| | 1–4 | 120 |

## 18. Tube-Testing Techniques

When trouble occurs in the standing wave indicator, check all cabling and connections before removing any tubes. Try to isolate the trouble to a component or stage. If tube failure is suspected, use the applicable procedure below to check the tubes.

**CAUTION: Do not rock or rotate a tube when removing it from a socket; pull it straight out with a tube puller.**

*a. Use of Tube Tester.* Remove and test one tube. Discard a tube only if its defect is obvious or if the tube tester shows it to be defective. Do not discard a tube that tests at or near its minimum test limit on the tube tester. Put back the original tube, or insert a new one if required, before testing the next one.

*b. Tube Substitution Method.* Replace a suspected tube with a new tube. If the equipment still does not work, remove the new

tube and put back the original tube. Repeat this procedure with each suspected tube until the defective tube is located.

*Note.* If tube V5, V6, or V7 is replaced, the output of the power supply circuit should be checked and readjusted (para 20).

## Section III. REPAIRS AND ALIGNMENT

### 19. General Parts Replacement Techniques

Most of the parts of the standing wave indicator can be reached and replaced easily without special procedures. The following precautions apply specifically to this equipment.

*a.* When servicing the panel-chassis assembly (fig. 9), do not disturb the settings of variable resistors R33 (meter expanded scale adjust) and R45 (B+ voltage adjust).

*b.* Before a part is unsoldered, note the position of the leads. If the part, such as the power transformer, has a number of connections, tag each lead.

*c.* Do not damage leads by pushing or pulling them out of the way.

*d.* Do not use a large soldering iron when soldering small resistors. Iron of less than 50 watts are recommended for soldering in this equipment. Overheating of small parts may damage or change the value of the component.

*e.* Do not allow drops of solder to fall into parts on the chassis; they may cause short circuits.

*f.* A carelessly soldered connection may create new faults. Make well-soldered joints; a poorly soldered joint is one of the most difficult faults to find.

*g.* Replace all parts in exactly the same position occupied by the original part. Use exact replacement parts if at all possible; a part which has the same electrical value but different physical size may cause trouble.

*h.* Give particular attention to proper grounding when replacing a part; use the same ground as in the original wiring. Failure to observe these precautions may result in range-to-range tracking erors.

*i* When replacing crystal diode CR1 or CR2, calibration of the EXPANDED scale may be necessary. Refer to paragraph 21 for the proper procedure to be used when calibration is necessary.

*j.* The precision (1 percent tolerance) film resistors located on the RANGE switch are carefully selected and matched for accuracy during manufacture. Careful replacement of individual resistors and wire leads is required when replacing any of these resistors.

### 20. Power Supply Adjustment and Regulation Test

Whenever V5, V6, or V7 is replaced, the output of the power supply should be checked as follows:

*a.* Connect the standing wave indicator to a variable power transformer. Connect the variable power transformer to the ac power source and adjust its output to 115 or 230 volts ac, depending on the connections of the power transformer in the standing wave indicator.

*b.* Connect the vtvm between pin 3 of V5 and chassis ground.

*c.* Apply power to the vtvm and to the standing wave indicator. Allow the equipment to warm up for approximately 5 minutes.

*d.* Adjust B+ voltage adjust resistor R45 to obtain a voltage reading of +245 volts dc.

*e.* Vary the output of the variable power transformer between 103 and 127 volts ac if the power source is 115 volts ac, or between 206 and 254 volts ac if the power source is 230 volts. The B+ output voltage should not vary more than ±2 volts.

*f.* Disconnect the vtvm and connect the ac vtvm between pin 3 of V5 and chassis ground. The ripple voltage should not be more than 5 millivolts.

### 21. Expanded Scale Calibration

*a. Test Equipment Required.*

(1) Audio oscillator TS–382D/U (or equivalent).
(2) Voltmeter, Meter ME–30A/U.
(3) Attenuator TS–402A/U(2) (or equivalent).

*Note.* Equivalent must be 600 ohms, 110-db range, 5 watts.

*b. Connections.* Connect the equipment as shown in figure 13.

*c. Control Settings.* Set the standing wave indicator controls as follows:

(1) VERNIER GAIN controls fully clockwise.

(2) RANGE switch to 0 DB.

(3) INPUT SELECTOR switch to XTAL 200Ω.

(4) METER SCALE switch to EXPAND.

(5) Power switch to ON.

*d. Procedure*

(1) Adjust the attenuator set for 20 db of attenuation.

(2) Tune the audio oscillator output through 1,000 cps to obtain a maximum reading on the standing wave indicator meter.

(3) Adjust the audio oscillator output level to obtain a reading of 0 on the EXPANDED DB scale of the standing wave indicator meter.

(4) Increase the attenuation of the attenuator set by 4 db. The standing wave indicator should now indicate 2 DB on the EXPANDED DB scale.

(5) If a 2 DB indication is not obtained, note the meter reading with relation to the 2 DB mark on the meter scale. Adjust expanded scale meter adjust resistor R33 to obtain an equal reading on the opposite side of the 2 DB mark.

(6) Repeat the procedure above until a 2 DB indication is obtained without further adjustment of R33.

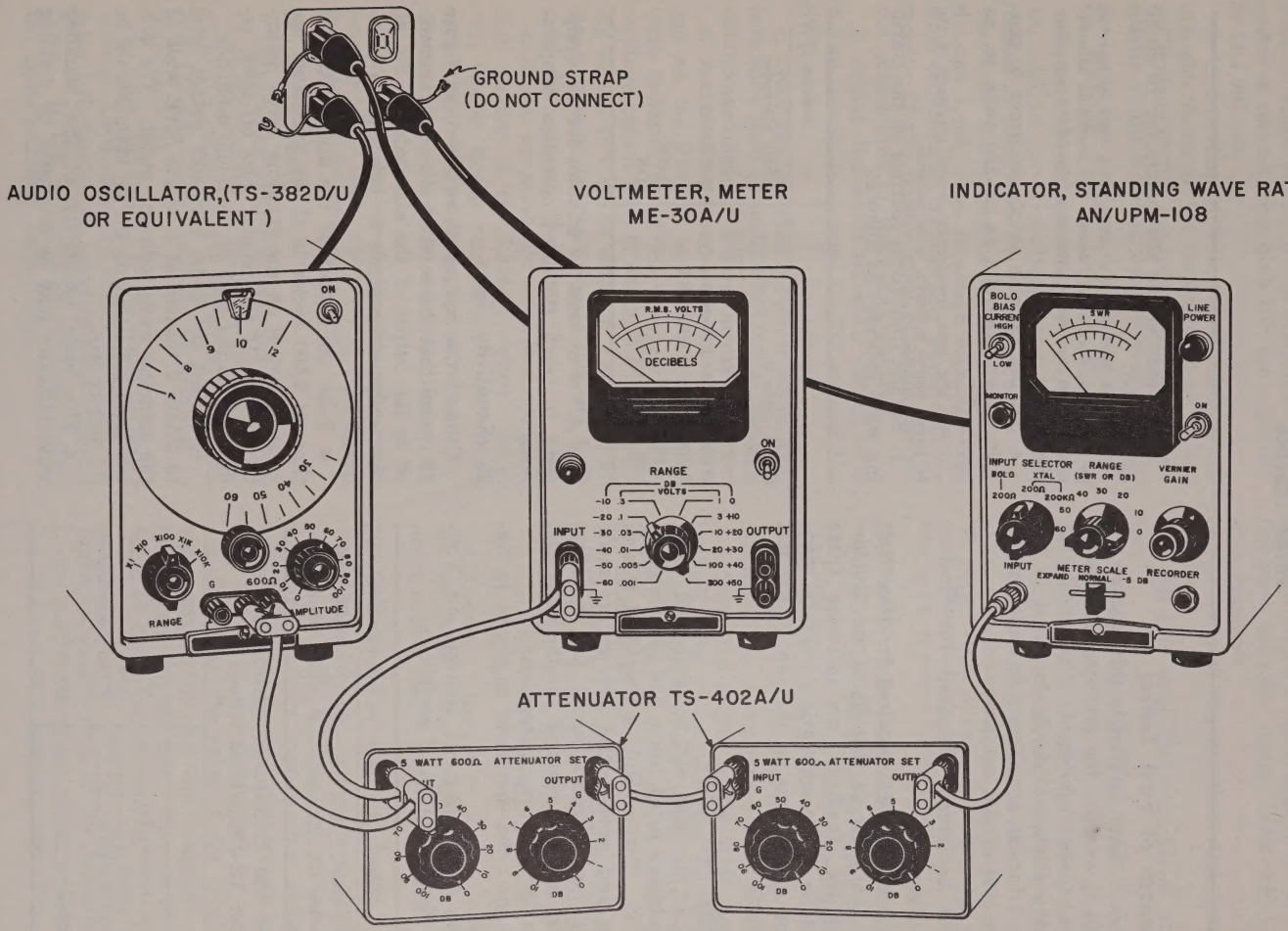



*Figure 13. Calibration test setup.*

# CHAPTER 3

# FINAL TESTING

## 22. Purpose of Final Testing

The static tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that meets the minimum standards stated in the tests will furnish satisfactory operation equivalent to that of new equipment.

## 23. Test Equipment Required for Final Testing

The test equipment required for final testing is the same as that listed for troubleshooting the standing wave indicator (para 12). Refer to the appropriate technical manuals for instructions on the use of the test equipment.

## 24. Basic Test Setup

Most of the tests will be performed under the conditions listed below and illustrated in figure 13. Testing will be simplified if connections and panel-control settings are made initially (as indicated below) and modifications are made as required for the individual tests in the following paragraphs.

*a.* Connect the equipment as shown in figure 13.

*b.* Set the front-panel controls on Voltmeter, Meter ME–30A/U as follows:

| Control | Position |
|---|---|
| RANGE switch | 10 VOLTS |
| Power switch | ON |

*c.* Set the front-panel controls on Audio Oscillator TS–382D/U as follows:

| Control | Position |
|---|---|
| Frequency selector dial | 10 |
| RANGE switch | X100 |
| AMPLITUDE control | 0 (fully counterclockwise) |
| Power switch | ON |

*d.* Set each of the attenuators for 10 db of attenuation.

*Note.* At least 20 db of attenuation must be inserted by the attenuators at all times. The maximum attenuation inserted by either attenuator should be not more than 80 db.

*e.* Set the variable autotransformer to provide either 115 volts ac or 230 volts ac, as required.

*Note.* The auto transformer is not necessary if the ac power source is known to be accurate.

*f.* Set the front-panel controls on the standing wave indicator as follows:

| Control | Position |
|---|---|
| GAIN controls | Fully clockwise |
| RANGE switch | 0 |
| INPUT SELECTOR switch | XTAL 200Ω |
| METER SCALE switch | NORMAL |
| BOLO BIAS CURRENT switch | LOW |
| Line power switch | ON |

*g.* Allow at least 10 minutes for all equipment to reach stabilized operation temperatures.

## 25. Sensitivity Test

Connect the equipment as shown in figure 13 except that the ac vtvm should be connected to the output of the attenuators. Set all test equipment controls as indicated in paragraph 24.

*a.* Tune the output of the audio oscillator through 1,000 cycles to obtain maximum upscale deflection on the standing wave indicator meter. If the pointer goes off-scale, reduce the output level of the audio oscillator.

*b.* Adjust the audio oscillator output level to obtain a reading of 1 on the SWR scale of the standing wave indicator meter. The output level indication on the ac vtvm should be 0.1 volt or less.

*c.* The basic sensitivity of the standing wave indicator may be calculated by dividing

the indication on the ac vtvm by 1,000,000. Each position of the RANGE switch multiplies the sensitivity by 10. When the RANGE switch is rotated from 0–60 DB, the sensitivity is 1,000,000.

*d.* If a reading of 1 on the standing wave indicator meter is not obtainable with an input voltage of 0.1 volt or less, the basic sensitivity of the standing wave indicator is low.

## 26. RANGE Switch Tracking Test

Connect the equipment as shown in figure 13. Adjust the front-panel controls as indicated in paragraph 24.

*a.* Tune the output of the audio oscillator through 1,000 cycles to obtain maximum upscale deflection on the standing wave indicator meter. If the pointer goes off-scale, reduce the output level of the audio oscillator.

*b.* Adjust the audio oscillator output level for an indication of 1 on the DB scale of the SWR meter.

*c.* Check the indication on the ac vtvm. This indication must be maintained during the procedures in *d* and *e* below.

*d.* Add 20-db attenuation in the attenuators and set the RANGE switch on the standing wave indicator to 10 DB. Adjust the audio oscillator output level to obtain the same reading on the ac vtvm as noted in *c* above. The standing wave indicator should indicate 1 db ±0.1 db.

*e.* Repeat the procedure given in *d* above for each position of the RANGE switch. Adjacent ranges should read within ±0.1 db of each other. Maximum accumulative error for all six ranges should be not more than ±0.2 db.

*Note.* An upscale error on the 60-db range can be caused by ground loops. There must be only *one* electrical path from the instrument to ground.

## 27. Noise Level

Connect the equipment as shown in figure 13 except that the ac vtvm should be connected to the output of the attenuator set. Adjust the front-panel controls as indicated in paragraph 24.

*a.* Tune the output of the audio oscillator through 1,000 cycles to obtain maximum upscale deflection on the standing wave indicator meter. If the pointer goes off-scale, reduce the audio oscillator output level.

*b.* Adjust the audio oscillator output level to obtain an indication of 0.03 volts on the ac vtvm. Record the indication of the standing wave indicator meter. This will be used as a reference.

*c.* Disconnect the ac vtvm and the audio oscillator.

*d.* Set both attenuators for 110-db attenuation.

*e.* Switch the standing wave indicator RANGE switch to 60 DB. The indication on the standing wave indicator meter should be less (downscale) than the reference reading obtained in *b* above.

*Note.* Readings with the RANGE switch in the 60 DB position should be made with the standing wave indicator in its case to prevent incorrect readings resulting from pickup of exterior electrical noise.

## 28. Switch Test, —5 DB (Meter Scale)

Connect the equipment as shown in figure 13. Adjust the front-panel controls as indicated in paragraph 24.

*a.* Adjust the attenuators to insert an additional 10-db attenuation (30 db total).

*b.* Tune the output of the audio oscillator through 1,000 cycles to obtain maximum upscale deflection on the standing wave indicator meter. If the pointer goes off-scale, reduce the audio oscillator output level.

*c.* Adjust the audio oscillator output level to provide a reading of 0 on the DB scale of the standing wave indicator meter.

*d.* Set the METER SCALE switch to the —5 DB position.

*e.* Decrease attenuation in the attenuator set by 10 db. The standing wave indicator meter should read 0 on the DB scale.

## 29. Bolometer-Bias Current Test

The bolometer-bias current test requires use of a 0- to 10-dc milliammeter with a known internal resistance, the monitor cable, a 1-watt composition terminating resistor, and a type UG–88/U connector plug.

*a.* Determine the value of the required resistor by subtracting the resistance of the milliammeter from 200. The result is the value of the required resistor.

*b.* Connect the monitor cable lug that is connected to the ring of the telephone plug to the positive terminal of the milliammeter.

*c.* Connect the monitor cable lug that is

connected to the tip of the telephone plug to the negative terminal of the milliammeter.

*d.* Insert the plug end of the monitor cable into the MONITOR jack on the standing wave indicator.

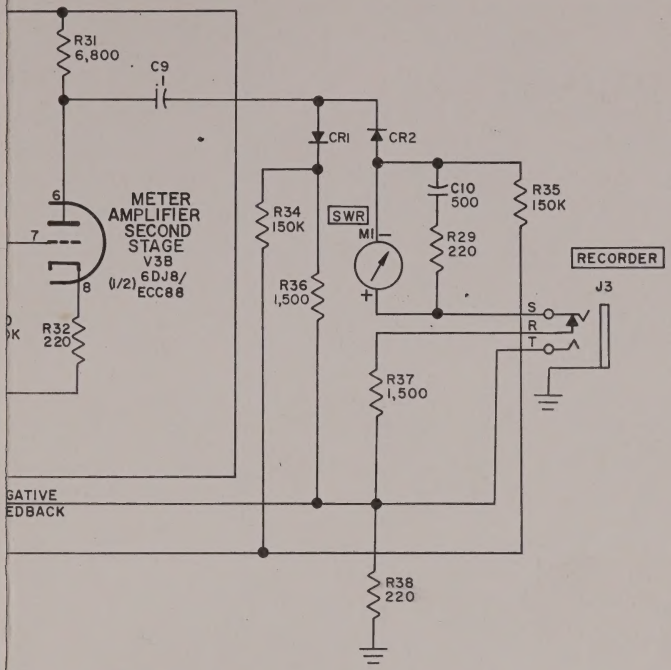
*e.* Connect the resistor between the center contact and the outer shell of a type UG–88/U connector plug.

*f.* Connect the UG–88/U connector plug to the INPUT connector on the standing wave indicator.

*g.* Place the INPUT SELECTOR switch in the BOLO 200 position.

*h.* Set the BOLO BIAS CURRENT switch to the HIGH position. The external milliammeter should indicate 8.4 $\pm$0.4 ma.

*i.* Set the BOLO BIAS CURRENT switch to the LOW position. The external milliammeter should indicate 4.3 $\pm$0.3 ma.




## NOTES

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF.
2. [ ] INDICATES EQUIPMENT MARKING.
3. S5 SECTIONS SHOWN IN EXTREME COUNTER CLOCKWISE POSITION (60DB), AND ARE VIEWED FROM SIDE ON WHICH SEGMENTS ARE MOUNTED. FRONT OF WAFER IS SIDE TOWARDS CONTROL KNOB. WAFER NEAREST CONTROL KNOB IS SECTION A.
4. ⏚ INDICATES GROUND TO COMMON TIE POINT.
5. F1 IS 0.5 AMP FOR 230 VAC OPERATION.
6. R22A, R22B HAVE CONCENTRIC CONTROL, SHAFTS.
7. S3 SHOWN IN [XTAL 200KΩ] POSITION.

connected to the tip of the telephone plug to the negative terminal of the milliammeter.

*d.* Insert the plug end of the monitor cable into the MONITOR jack on the standing wave indicator.

*e.* Connect the resistor between the center contact and the outer shell of a type UG–88/U connector plug.

*f.* Connect the UG–88/U connector plug to the INPUT connector on the standing wave indicator.

*g.* Place the INPUT SELECTOR switch in the BOLO 200 position.

*h.* Set the BOLO BIAS CURRENT switch to the HIGH position. The external milliammeter should indicate 8.4 ±0.4 ma.

*i.* Set the BOLO BIAS CURRENT switch to the LOW position. The external milliammeter should indicate 4.3 ±0.3 ma.

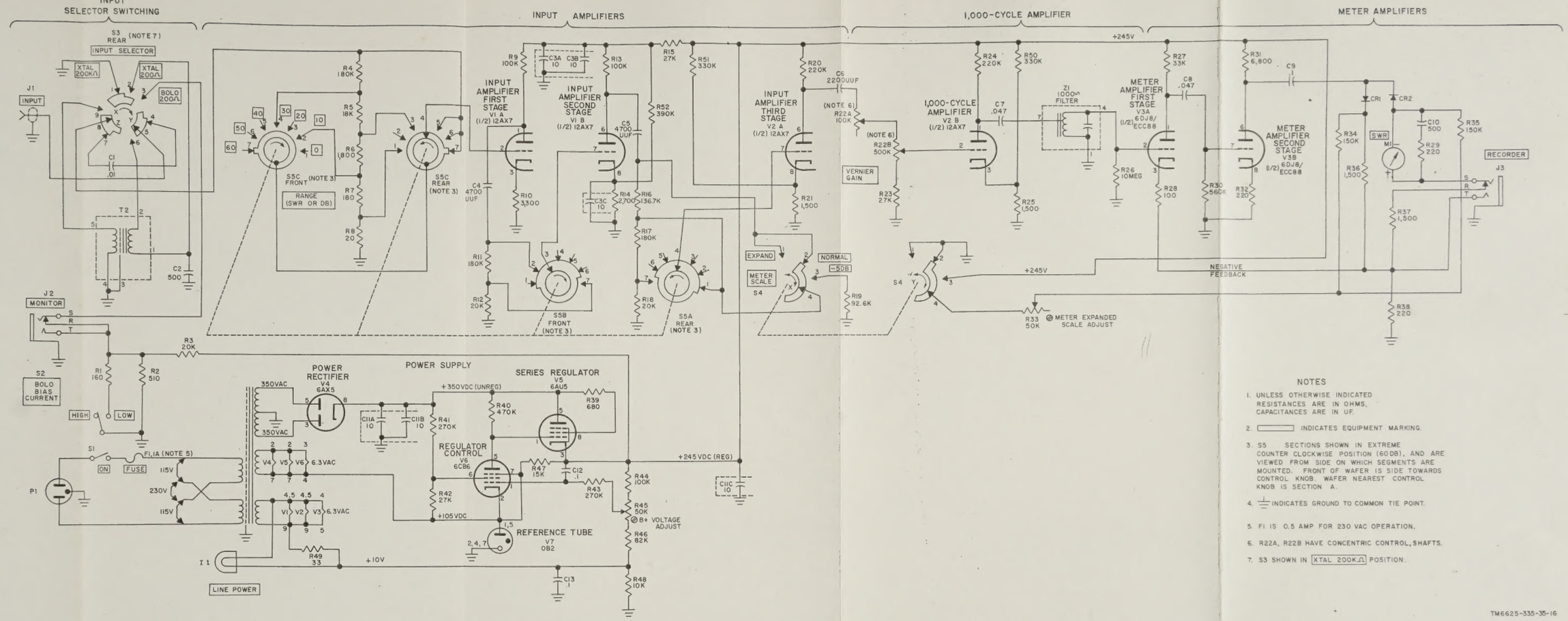
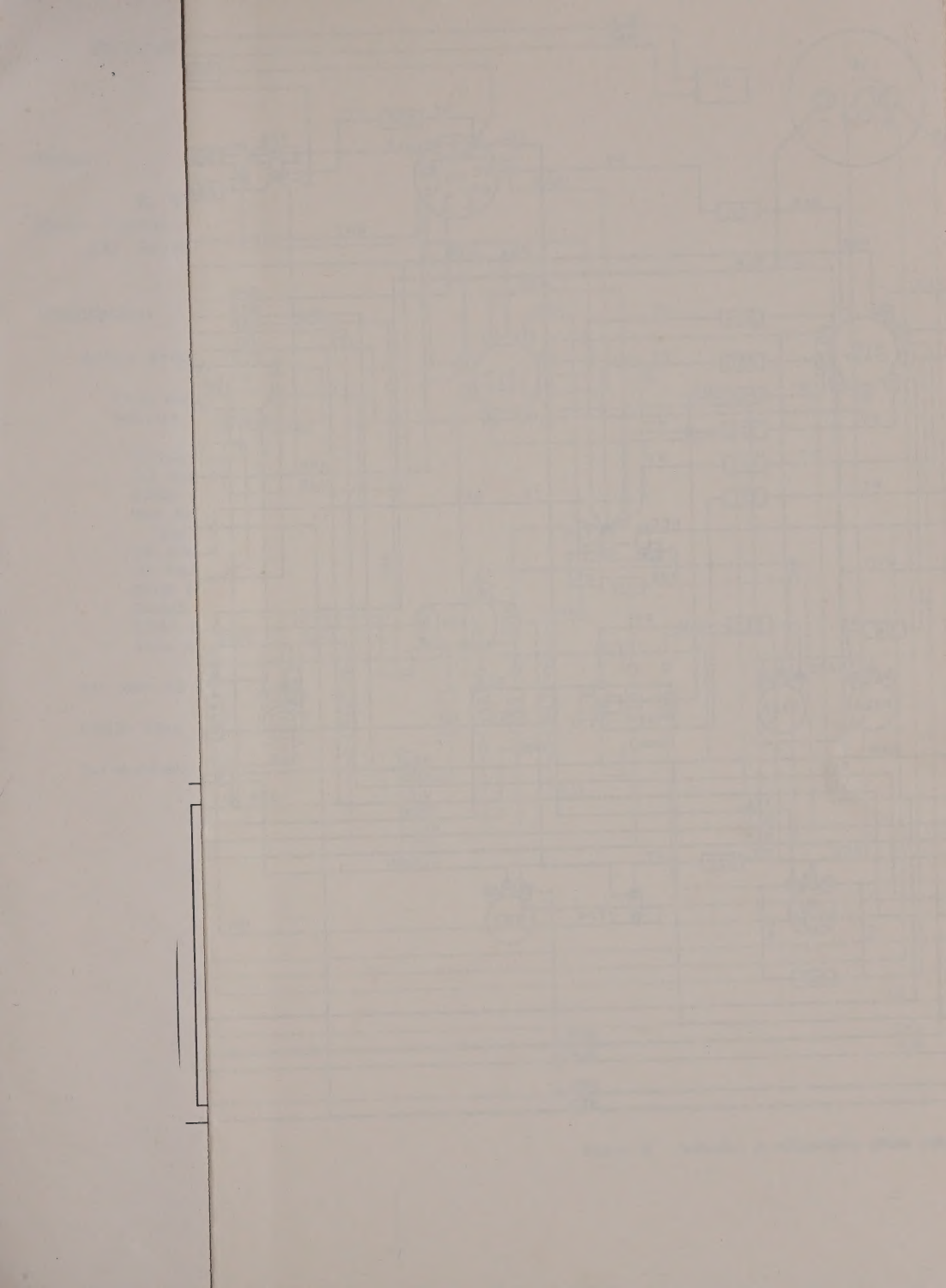



*Figure 16. Indicator, standing Wave Ratio AN/UPM-108, schematic diagram.*

NOTES

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF.
2. ▭ INDICATES EQUIPMENT MARKING.
3. S5 SECTIONS SHOWN IN EXTREME COUNTER CLOCKWISE POSITION (60DB), AND ARE VIEWED FROM SIDE ON WHICH SEGMENTS ARE MOUNTED. FRONT OF WAFER IS SIDE TOWARDS CONTROL KNOB. WAFER NEAREST CONTROL KNOB IS SECTION A.
4. ⏚ INDICATES GROUND TO COMMON TIE POINT.
5. F1 IS 0.5 AMP FOR 230 VAC OPERATION.
6. R22A, R22B HAVE CONCENTRIC CONTROL, SHAFTS.
7. S3 SHOWN IN XTAL 200K/Λ POSITION.

TM6625-335-35-16



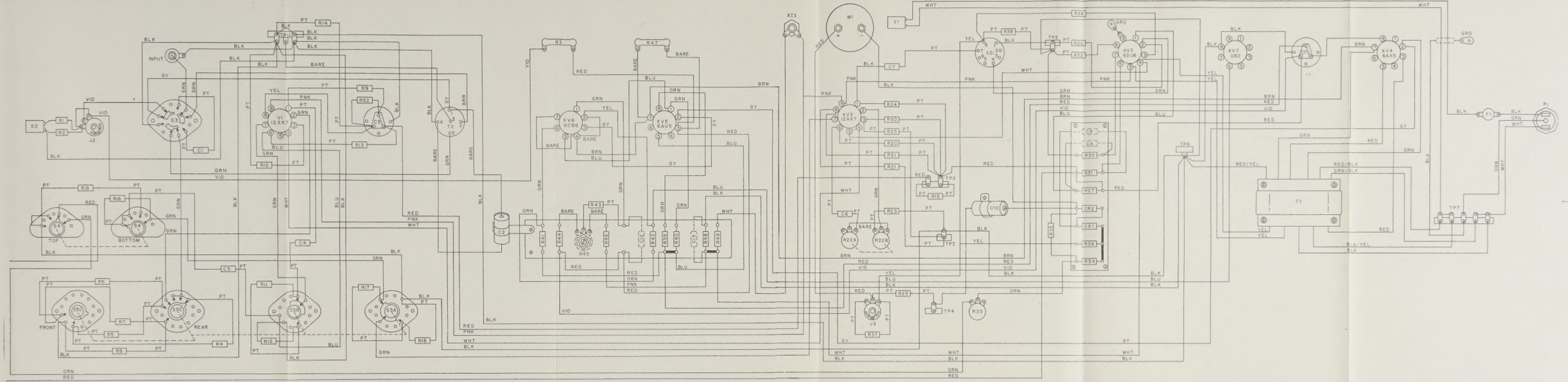



*Figure 17. Indicator, Standing Wave Ratio AN/UPM-108, wiring diagram.*

TM6625-335-35-17

By Order of *Wilber M. Brucker*, Secretary of the Army:

L. L. LEMNITZER,
*General, United States Army,*
*Chief of Staff.*

Official:

R. V. LEE,
*Major General, United States Army,*
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*NG*: State AG (3).

*USAR*: None.

For explanation of abbreviations used, see AR 320-50.